

### When protoindustry collapsed fertility and the demographic regime in rural Eastern Belgium during the industrial revolution

Alter, George; Oris, Michel; Neven, Muriel

Veröffentlichungsversion / Published Version

Zeitschriftenartikel / journal article

**Zur Verfügung gestellt in Kooperation mit / provided in cooperation with:**

GESIS - Leibniz-Institut für Sozialwissenschaften

#### Empfohlene Zitierung / Suggested Citation:

Alter, G., Oris, M., & Neven, M. (2007). When protoindustry collapsed fertility and the demographic regime in rural Eastern Belgium during the industrial revolution. *Historical Social Research*, 32(2), 137-159. <https://doi.org/10.12759/hsr.32.2007.2.137-159>

#### Nutzungsbedingungen:

Dieser Text wird unter einer CC BY Lizenz (Namensnennung) zur Verfügung gestellt. Nähere Auskünfte zu den CC-Lizenzen finden Sie hier: <https://creativecommons.org/licenses/by/4.0/deed.de>

#### Terms of use:

This document is made available under a CC BY Licence (Attribution). For more Information see: <https://creativecommons.org/licenses/by/4.0>

## When Protoindustry Collapsed Fertility and the Demographic Regime in Rural Eastern Belgium During the Industrial Revolution

*George Alter & Michel Oris & Muriel Neven\**

**Abstract:** The story of the Demographic Transition is often told as a contrast between a dynamic urban-industrial sector and a static and traditional countryside. Rural areas are viewed as bastions of stability that resisted the transformative economic and cultural forces emanating from urban centers. This stereotype ignores the transformation occurring within the rural sector, in both its relationships with the urban-industrial world and its own internal economy. Looking at their demographic regime, especially the fertility pattern, we see that to a large extent, inhabitants of East Belgian countryside were able to cope with rural deindustrialization, population pressure and urban industrial development. It is not reasonable to see their late transition to low marital fertility as a lack of adaptive capacities, when they showed exactly the contrary throughout the century.

When John Cockerill arrived in a town named Verviers to build spinning machines in 1801, Eastern Belgium already had a strong industrial base in textiles and iron products. In the following decades Cockerill and his sons helped to make Verviers the first center of mechanized textile production on the European continent. Then, they moved to the Chateau of Seraing in the Liège basin to build an empire of coal, iron, steel, and machine-building. This industrial transformation had profound implications for the surrounding countryside, which underwent a process of de-industrialization and agricultural consolida-

---

\* Address all communications to: George Alter, Department of History, Indiana University, Bloomington, IN 47408, USA; e-mail: [alter@indiana.edu](mailto:alter@indiana.edu); Michel Oris, Laboratoire de Démographie et d'Etudes familiales et Département d'Histoire économique, Université de Genève, 40 bd. du Pont d'Arve, 1211 Genève 4, Switzerland; e-mail: [michel.oris@histec.unige.ch](mailto:michel.oris@histec.unige.ch); Muriel Neven, Laboratory of Demography, University of Liège (Bat. A4), 1b, quai Roosevelt, 4000 Liège, Belgium; e-mail: [muriel.neven@ulg.ac.be](mailto:muriel.neven@ulg.ac.be).

**Authors' note:** We express our gratitude to Floriane Demont, PhD student at the Laboratory of Demography and Family Studies, Geneva University.

tion. The rural areas were themselves varied in 1801, with advanced market-oriented agriculture in the Pays de Herve north of Verviers and subsistence farming in the Ardennes to the south. By 1901 both rural regions had adapted to their new roles in the modern industrial economy. In this paper, we will consider rural adaptations to the collapse of the protoindustrial system and the realignment of the rural economy.

The story of the Demographic Transition is often told as a contrast between a dynamic urban-industrial sector and a static and traditional countryside. Rural areas are viewed as bastions of stability that resisted the transformative economic and cultural forces emanating from urban centers. This stereotype ignores the transformation occurring within the rural sector, in both its relationships with the urban-industrial world and its own internal economy. Rural areas in Eastern Belgium were already part of the world economy at the beginning of the nineteenth-century, and they were closely linked to the changes occurring in nearby urban centers. Furthermore, there were marked differences among the rural populations of Eastern Belgium before the onset of fertility decline.

The demographic transformation of rural Eastern Belgium is an example of a “multiphasic response” (Davis 1964), and we see not one but several demographic regimes. After recovering from the difficult years of famine and epidemic following the Napoleonic Wars, these rural populations faced the dual problems of growing population and dwindling opportunities for domestic industry. They responded within the Malthusian framework by restricting access to marriage, but they also increased migration to urban areas and eventually reduced marital fertility. Paradoxically, the transition to family limitation only occurred after a quarter century of rising marital fertility. This pattern, rising fertility immediately before the onset of fertility decline, has been observed in other parts of Belgium and elsewhere (Knodel 1988: 283-286; Alter 1988: 175; Perrenoud 1988b: 69; Lesthaeghe 1992: 310). During the 1850s and 1860s low nuptiality and high out-migration were being used to reduce population pressure, but rising marital fertility and falling mortality kept the rate of natural increase high.

The shift from a Malthusian to a Neo-Malthusian strategy after 1870 did not involve the abandonment of the earlier pattern. Marriage ages did not drop as marital fertility began to fall. Rather, late marriage was transformed from a survival strategy to a strategy for social and economic mobility. In the first half of the nineteenth century late marriage and out-migration may have been responses to economic decline, but after 1850 they allowed those who remained in rural areas to consolidate properties and introduce more advanced agriculture. In one sense, the rural inhabitants of Eastern Belgium did not abandon the Malthusian logic of late marriage, but they added new demographic behaviors (out-migration and family limitation) and new aspirations consistent with the changing economy.

## Communities and Sources

### Contrasted experiences in a changing world

Our research focuses on two areas located in Eastern Belgium, on the borders with Germany and the Netherlands. This was the first region on the continent to follow the British example, experiencing rapid industrial development from the late 18<sup>th</sup> century. The process was initially centered on textile factories in the town of Verviers, then on the growth of a modern iron and steel industry located on the coal basins surrounding the city of Liège (van der Herten et al. 1995). These urban-industrial agglomerations grew from 65,000 to almost 500,000 inhabitants between 1800 and 1900 (Oris 1990). We investigate demographic patterns in the municipality of Sart, located in the Ardennes region of Eastern Belgium, and in the three villages of Charneux, Clermont and Neufchâteau, situated in the heart of the Pays de Herve. All these localities are less than 20 km from Verviers and 40 km from Liège. In spite of the small distance between them, these two regions – the Ardennes and the Pays de Herve – had different geographic characteristics, as well as different agrarian, demographic, social and economic histories. The rural and urban were interdependent in nineteenth-century Eastern Belgium, and the populations of the Ardennes and the Pays de Herve could not have developed as they did without opportunities for migration to places like Verviers and Liège.

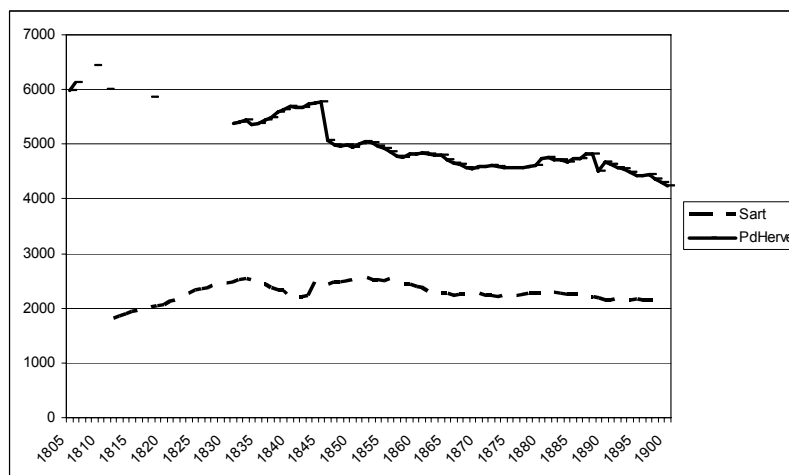
The divergent experiences of our case studies are due to very different ecologies. The municipality of Sart, adjacent to Germany until 1919, consists of a half dozen hamlets located on the northern slopes of a high plateau of peat bogs and forests called the “Hautes Fagnes”. In the eighteenth century iron forges had used charcoal from these forests, but they disappeared after coke-based forges developed in the Liège basin. Most of the inhabitants were small-holders on middle-sized farms. They depended heavily on the area’s abundant, communally owned forests for wood and forage for livestock, as well as slash and burn agriculture, which continued into the nineteenth century. An 1847 law encouraged the sale of common land and the formation of large estates, but these farms were not economically viable and rapidly abandoned (Hoyois 1981: 154-176). In the second half of the nineteenth century, more progressive agricultural practices emphasizing livestock were introduced, and timber was sold for the coal mines around Liège (Alter and Oris 2000).

The Pays de Herve, a plateau of rolling meadows and orchards, on the northern side of the Vesdre valley had a quite different history. During the sixteenth century merchant-clothiers from Verviers recruited peasants to spin and weave wool for sale abroad. Involvement in the emerging modern economy also stimulated an early transition from subsistence to commercial agriculture based on cattle breeding and the production of cheese and fruits. Hervian peasants prospered under this system. Landownership increased, and common

lands disappeared (Servais 1981). When factories and machines reached Verviers in the early nineteenth century, this system was suddenly destroyed. Rural spinning had disappeared by 1830, and handloom weavers experienced the same fate around 1860. By that time, the decline in peasant property ownership had reached its climax, and most farmers were renting land from noble or bourgeois owners. The modernized agriculture of the Pays de Herve, however, remained profitable and dynamic during the second half of the nineteenth century (Neven 2003).

The demographic histories of the two areas also diverged, as we can see in Figure 1. The Pays de Herve responded to the demise of proto-industry with a 10 percent population loss between 1800 and 1830. Then, the number of inhabitants was overestimated until the first modern population census, in 1846, proved the decline. But the three villages in our sample were roughly stable around 4,600/4,700 people from 1850 until 1890. In Sart, the traditional economy sustained an increase from 1,800 inhabitants in 1812 to 2,500 in 1850, and then population fell back to its starting level by 1900. These population movements were less determined by the “natural” difference between fertility and mortality than by extensive migration in a dynamic regional economy.

Fig. 1: Population of Sart and the Pays de Herve in the nineteenth century



### Data and methods

The information presented in this paper is derived from population registers. Beginning in 1846 these documents were opened after each census, and kept up to date to reflect all the population changes in each locality: births and deaths as well as in- and out-migrants were recorded as they occurred. Of course, a

margin of error separated theory and practice. Infants that died soon after birth were not transcribed into the population register, and migrants sometimes failed to report their movements, especially when they left a commune. We have used the registers of births, deaths, and marriages, which are highly accurate, to correct many of these problems, and unknown dates of out-migration have been assigned at random, when necessary (see Alter, Oris, and Neven 2004b, 179-180, for more details). The available population registers cover different periods of time. The longest series (1812 to 1899) is available for Sart, which was one of a small number of communities that opened population registers under the Napoleonic Empire. Population registers for the Pays de Herve begin in 1846, when they were instituted throughout Belgium after the census in that year. We can follow the three localities in the Pays de Herve until 1900.

Population registers are exceptionally good sources for demographic analysis (see Alter 1988.) Since the population register records dates of in- and out-migration, we are able to reconstruct the population at risk at every point in time. In addition, population registers give us information about changes in household composition. This is not the conjugal family, used in the family reconstitution techniques pioneered by Louis Henry, but the social and economic unit that shared a roof and hearth. Relationships among members of a household are often indicated or can be inferred from other information, but they are not necessarily related by blood: servants, apprentices, and other workers who also contributed directly to the resources of the household are also included.

Most other historical demographic research is limited by the elaborate rules of family reconstitution, which were developed for situations where births, deaths, and marriages are known but migration is not recorded. Since migration is recorded in population registers, a much wider range of analyses are possible. It is possible not only to include groups, such as migrants and unmarried persons, who are often excluded by other methods, and to pose new questions. Many of these issues remain to be examined, and relatively little has been written about the effects of household composition on fertility except for Alter's (1988) work on the female life course in Verviers and, more recently, Jan Van Bavel's (2001a and 2001b) research on the city of Leuven in the Flemish part of Belgium.

It should also be mentioned that this analytical approach has some costs as well. In particular, we have not tabulated information on completed family size. This calculation can only be performed for couples observed from marriage until the wife completes her childbearing. Consequently, it excludes couples in which a spouse dies early, those who migrate out of the community, and those censored by the end of available information. Thus, it would limit us to the same select sub-population available for family reconstitution. This issue is particularly important in the Pays de Herve, where families moved frequently.

If our analysis was limited to completed families, it would exclude two thirds of the births (Neven 2003, 27)!

## The preindustrial demographic regime and the proto-industrial challenge

Previous work has viewed pre-industrial Belgium through a Malthusian lens emphasizing demographic behaviors that tended to keep population growth in balance with limited resources. The key to this system was the link between property and household formation. As long as economic independence was a prerequisite for marriage, growth in population would eventually be reversed when diminishing access to resources made it more difficult to marry. In times of population pressure young people were forced to postpone marriage until inheritance or savings brought them a farm or livelihood. Alternatively, they could migrate to the cities, whose high mortality rates consumed excess rural population. Carlo Corsini observed that “Any family system could not maintain itself but through controlling marriage and migration solutions. Migrations and marriages appear to be the most sensitive and important factors of family behavior (...) in historical populations, characterized by ‘natural’ fertility and when mortality is depending mostly on external elements, not on the individual choice” (Corsini 2000: 18).

This perspective often views variations in fertility as secondary phenomena. Marriage was the most important determinant of fertility, and reproduction within marriage followed a regular pattern (Flinn 1981: 19-20). In their classic work on the population history of England Wrigley and Schofield (1981) show that fertility was more responsive to fluctuations in real wages than life expectancy, but they see these adjustments as operating through the association between fertility and nuptiality (See also Weir 1984 and Schofield 1985). This does not mean that fertility within marriage was uniform. The comparison of several French case-studies has shown that levels of fertility varied widely, even without contraceptive practices (Bideau, Bardet, Houdaille 1988: 367). These differences are attributed to a variety of behaviors, especially variations in the duration of breastfeeding, which are not evidence of family limitation.

The expansion of cottage industry in the countryside posed a challenge to this demographic regime. By providing a secondary source of income, rural industry reduced the amount of land necessary to support a family, weakening the preventive check and unleashing population growth. Rudolf Braun (1990) described this process in the Bern Oberland and similar developments have been described in Flanders, England, Germany, and elsewhere (Levine 1977). In 1972 Franklin Mendels coined the term “protoindustrialization” to describe the role of cottage industry in the development of markets and capital preced-

ing the Industrial Revolution. An integral part of this process was the interaction between population growth and economic development. Growing population encouraged further economic development, but it also offset increasing productivity to prevent an increase in the standard of living (Mendels 1972: 252). Medick argues that the interaction between population expansion and economic growth resulted in a “reproductive ‘overreaction’” leading to the decay and eventual demise of the protoindustrial system itself (Kriedte, Medick, and Schlumbohm 1981: 74). Thus population growth induced by proto-industrialization could set the stage for disaster in the nineteenth century, when mechanized production undermined the viability of domestic industry. Protoindustrialization has been blamed for the nineteenth-century crisis in Flanders, where the decline of domestic linen production caused severe poverty.

Recent studies have criticized the demographic side of the protoindustrialization hypothesis. Vandenbroeke (1984: 934) argued that protoindustrialization in eighteenth-century Flanders affected population growth primarily by reducing out-migration to cities, rather than easing restrictions on marriage. Gutmann and Leboutte (1984) also fail to see a dramatic decrease in marriage ages in the Basse Meuse and Pays de Herve, such as those observed by Braun (1990) in Switzerland and Levine (1977) in England. Gutmann (1988: 169) found that workers involved in textile production did marry earlier than farmers, but he points out that their average ages at marriage were still in the late 20s. Even Mendels (1984: 951-952) in his rejoinder to Vandenbroeke cites average ages at marriage that must be considered late compared to non-European standards. Leboutte (1996: 4) argues that the demographic effects of proto-industrialization varied depending upon local conditions. In the Pays de Herve the spread of cottage industry was gradual, and it was accompanied by improvements in agriculture as well. Herviens not only retained their attachment to the land; land ownership actually increased during the eighteenth-century (Servais 1982: 304-305).

Although the impact of proto-industry on marriage patterns has been discounted by some participants in this debate, they all share Malthusian assumptions about reproduction in pre-industrial Belgium. More recent writers, like Gutmann, Leboutte, and Vandenbroeke, do not reject the view that nuptiality was linked to the availability of resources, rather they suggest that the cultural patterns producing late marriage were deeply rooted and related to economic change in more complex ways. Marriage is still considered the primary determinant of family size, and reproduction within marriage is assumed to have been uncontrolled. We see the persistence of this system in Eastern Belgium during a period of urban expansion and rural de-industrialization.

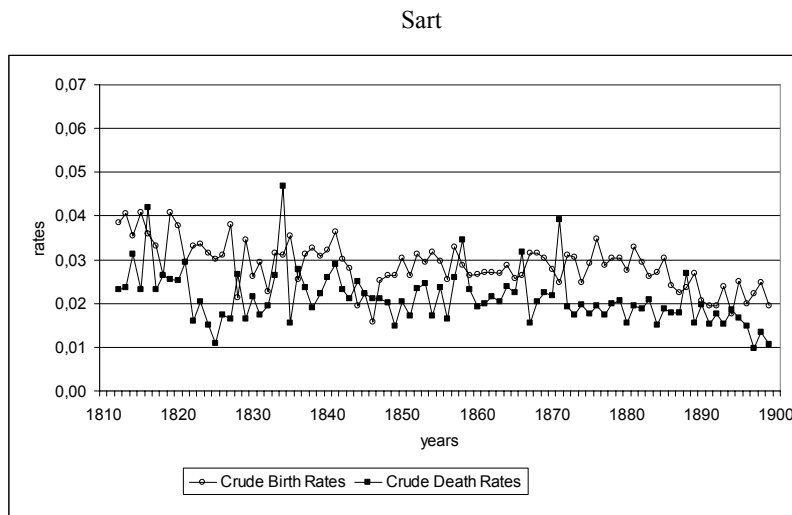


## Managing population pressure: from marriage to marriage and migration

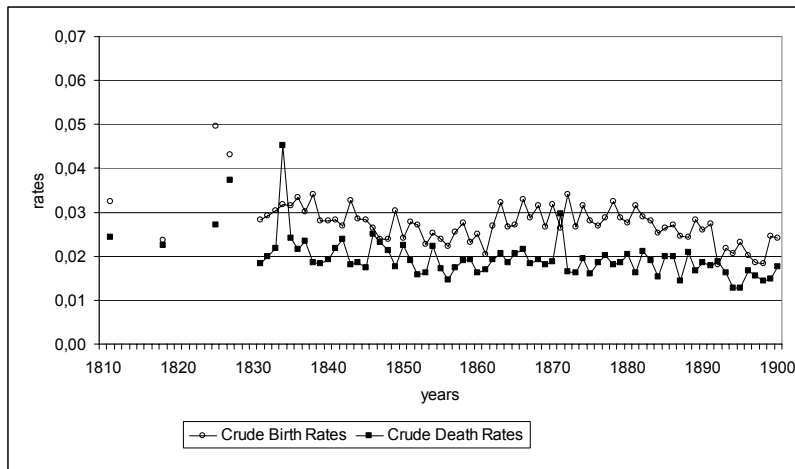
Figure 2 shows the course of crude birth and death rates in our study areas. In Sart, which we follow from 1812, the jagged patterns in both series suggest how susceptible the community was to epidemics and economic crises. Higher birth rates early in the century were largely due to earlier marriage after the disastrous years surrounding the Napoleonic Wars. As mortality stabilized and population pressure returned, ages at marriage rose and the birth rate decreased. From 1830 we can observe the Pays de Herve. The birth rates in both rural areas remained constant from about 1850 to 1885, but they were distinctly lower during the last decade of the century.

Mortality was substantially lower than fertility in both rural areas. The main difference is that crises were more limited in the more prosperous Pays de Herve than in the Ardennes. Even after 1850, epidemics – such as smallpox in 1871 – are evident in Sart, although such misfortunes seem nothing compared to the ravages of cholera and other diseases in the growing urban industrial areas (Alter, Neven, Oris 2004b: 180-184).

Fig. 2: Crude birth and death rates. Sart, the Pays de Herve and Tilleur in the nineteenth century



### Pays de Herve



In the long run, an excess of births over deaths had important implications for other behaviors, because it created pressure within both families and communities. Rural areas in Eastern Belgium had long followed the Malthusian strategy of restricting marriage to balance population and resources. Norms requiring each couple to form a new household soon after marriage linked economic opportunities to marriage. Since the Belgian Civil Code, which was based on the Napoleonic Code, called for the equal division of inheritances, population growth implied that farms would become smaller as the number of heirs in each generation increased. In addition, industrialization in Verviers undermined cottage industry, which had contributed to the prosperity of the Pays de Herve during the eighteenth century. Consequently, ages at marriage were high and many women did not marry at all.

The average age at marriage for women in Sart was between 26 and 28, depending upon the way in which it is calculated (Alter and Oris 1999: 135-136), and it was above 28 in the Pays de Herve (Neven 2003: 323-324). In addition to marrying very late, 22 percent of women aged 45-49 in the Pays de Herve had never been married at all, and this proportion was rising during the second half of the century.<sup>1</sup> Indeed, between 1873 and 1890 the increase in permanent celibacy in the Pays de Herve restrained the growth of the Total Fertility Rate at a time when marital fertility was rising and the average age at marriage was

<sup>1</sup> For comparable estimates in nineteenth century Belgium see Leboutte 1988: 293; Alter and Oris 1999: 136; Vandenbroeke 1984: 938.

stable. In comparison, only 12 percent of 45-49 year-old women had never been married in Sart, where out-migration was more heavily female.

Fig. 3: Evolution of the index of proportion married,  $I_m$ , Sart, the Pays de Herve and Tilleur

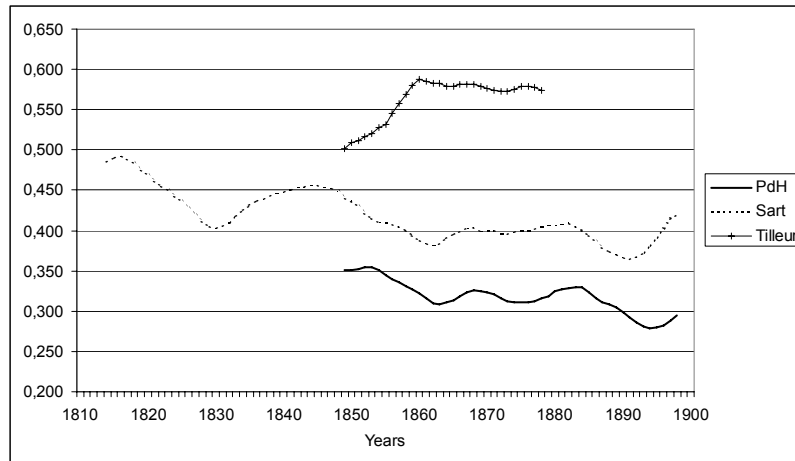


Figure 3 shows trends in marriage with the  $I_m$  index, which estimates the effect of marriage patterns on fertility.<sup>2</sup> The fertility of women in Sart was only 47 percent of what it would have been if all women had married, and in the Pays de Herve late marriage and permanent celibacy reduced fertility to only 39 percent of its potential. The inhabitants of the Pays de Herve appear to have been especially hard pressed. Six of every ten Hervians between 15 and 49 were unmarried, and two thirds of women aged 25-29 were not yet married. The situation in the Ardennes was similar, even if the age at marriage was somewhat younger. In both areas the proportion married decreased throughout the nineteenth century. The old Malthusian system limiting access to marriage – at least locally – was maintained and even reinforced by these rural populations, while protoindustry collapsed and industrialization progressed spectacularly in nearby towns.

The importance of the old Malthusian restraints among East Belgian rural families is confirmed in Table 1 by the difference between marital fertility

<sup>2</sup> The  $I_m$  index was developed by the European Fertility Project to estimate the effect of marriage patterns on fertility. It uses the age-specific fertility rates of Hutterite women, a high fertility religious community, to compute the expected fertility of women at ages 20 through 49.  $I_m$  is a ratio of the expected number of births to married women to the number expected if all women were bearing children at the rates of the Hutterites. See Coale and Watkins (1986: 153-162).

(TMFR20+) and the Total Fertility Rate (TFR). The TFR shows the average number of births per woman for all women, not just those who were married. In the Pays de Herve the TFR was less than half of TMFR20+, i.e. 3.7 children per woman compared to 8.7 per married woman, because so many women in the childbearing ages were unmarried. Marriage also had a large effect on fertility in Sart, where the TFR was a little more than half of TMFR20+. In contrast the TFR was much higher (5.6 children per woman) in the industrial suburb of Tilleur, where the gap between TFR and TMFR20+ was lower. Thus, differences in fertility were strongly affected by the timing of marriage, which was particularly late and restricted in the Pays de Herve and relatively early and more universal in Tilleur.

Tab. 1: Net Reproduction Rate (NRR), Total Fertility Rate (TFR) and Total Marital Fertility Rate above Age 20 (TMFR 20+) for Sart, the Pays de Herve and Tilleur

Dec-ades	Sart			Pays de Herve			Tilleur		
	TMFR 20+	TFR	NRR	TMFR 20+	TFR	NRR	TMFR 20+	TFR	NRR
1812-1819	7.9	4.6	1.23						
1820-1829	7.7	4.4	1.40						
1830-1839	7.8	4.2	1.13						
1840-1849*	8.5	4.8	1.46	8.4	3.9	1.19	6.8	4.8	0.97
1850-1859	8.9	4.9	1.53	8.2	3.6	1.28	8.0	5.5	1.36
1860-1869	8.8	4.7	1.32	8.9	3.9	1.33	7.9	5.9	1.57
1870-1879	8.9	4.7	1.44	9.2	4.0	1.48	7.4	5.5	1.75
1880-1889	8.5	4.4	1.54	9.0	3.8	1.34			
1890-1899	6.7	3.3	1.20	8.1	3.1	1.13			
All	8.2	4.4	1.33	8.7	3.7	1.30	7.7	5.6	1.58

\* = 1846-1849 for Tilleur and the Pays de Herve

It was precisely in those expanding urban industrial areas that the traditional restraints of late marriage and a high level of permanent celibacy were broken, increasing the contrast between rural and urban populations. Figure 3 includes the  $I_m$  index in Tilleur, a locality located in the outskirts of Liège in the most dynamic part of the coal and steel basin. Tilleur began the century smaller than our rural study sites and hardly more urban, but it grew from 507 to 6,642

inhabitants between 1807 and 1900. Population growth started just after the establishment of two modern coal-mines in 1828 and 1835. (See more about Tilleur in Alter, Neven, and Oris 2004b, especially 193-200). Marriage patterns in an industrial place like Tilleur were almost a mirror image of those in the rural areas. Between 1831 and 1880 the average female age at marriage fell by three years reaching 25.6 years in 1880. Even the average male age at marriage fell from 32.1 to 28.7 despite an increasingly unbalanced marriage market. During the first phase of explosive urban growth, the sex ratio in Tilleur rose from 93 men per hundred women in 1830 to 119 in 1856, because of the influx of young men headed for the mines and mills (Oris 2000, 395). Abundant opportunities for employment encouraged the formation of new households, and both the female age at marriage and proportion never marrying decreased. This loosening of Malthusian marriage rules increased the birth rate, which helped to compensate for high child mortality and epidemics characteristic of urban areas (Oris 1996). In the context of Eastern Belgium, the movement towards younger marriage in Tilleur places it at the opposite extreme from the Pays de Herve.

Industrial expansion in places like Tilleur and in the textile region of Verviers created an alternative response to rural population pressure: migration. Migration was not a new phenomenon in Eastern Belgium. Indeed, when the Industrial Revolution occurred, the Pays de Herve was receiving migrants from other places (Gutmann 1991). Nevertheless, increasing population pressure and the collapse of rural industry led to more and more rural to urban migration (Neven 2003: 123-125). In Sart, where Malthusian tension between population and resources grew during the first part of the nineteenth century, out-migration began in earnest only after 1850. Sart was not as involved in the textile industry as the Pays de Herve, and its small, closely knit hamlets may have clung more tightly to their way of life until no other option was left. The 1847 law, which was intended to promote an agricultural modernization and encourage the sale of common lands that were vital for the poor peasants of Sart, was probably decisive, adding a “push” to the “pull” of industrial areas. These differences affected the character of migration from each place. On the plateau of Herve migration was more equally spread within and among families (Neven 2003: 249-250). In Sart, on the other hand, women were more likely to migrate than men, and it appears that some lineages succeeded in staying in place while others were forced to move (Capron 1998). Since migration was not an established and accepted part of the demographic system, new rules had to be developed, and the burden was less evenly spread across the population (Hoyois, 1981, 670).

By providing an outlet for excess population, the urban/industrial sector also encouraged economic progress in rural areas. The productivity of agriculture increased in both Sart and the Pays de Herve as farms grew in size and value during the second half of the nineteenth century. In Sart, population decrease

due to out-migration made it possible for those who remained to consolidate their holdings and employ more modern techniques, such as artificial fertilizer (Hoyois 1981: 163). The process was somewhat different in the Pays de Herve, where much of the land was purchased by urban rentiers, but farms were consolidated into larger units and agricultural techniques continued to advance (Neven 2003: 73). These developments offset any tendency toward earlier marriage due to the improving rural economy. The process of farm consolidation continued to reduce opportunities for household formation, and those who wanted to marry at a younger age could migrate to the growing industrial cities, leaving their shares of the family farm to more patient siblings.

As Gutmann and Leboutte (1984) observed, protoindustrialization had not erased the preventive check in Eastern Belgium, and the de-industrialization of the countryside in the early nineteenth century was accompanied by even more restrictive marriage patterns. Malthusian marriage, however, could not offset the demographic pressure caused by lower mortality, high marital fertility, and the demise of the proto-industrial economy. Out-migration allowed the rural economy to adapt to the new economic and demographic realities and fueled industrial expansion in places like Verviers and Tilleur. Economic opportunities did result in some easing of Malthusian constraints in urban areas. Ages at marriage fell as Tilleur grew<sup>3</sup>, even though the imbalanced sex ratio favored women over men.<sup>4</sup> Consequently, urban-rural differences in access to marriage widened. It is important to note, however, that these urban marriage ages can only be considered young in comparison to their rural counterparts. Most men and women still waited until their late twenties to marry. Alter (1988) has suggested that parents had an interest in delaying the marriages of their children, whose contributions to the family economy supported younger siblings and eased the transition into old age. Moreover, marriage ages did not go down in rural areas even though population pressure began to recede in the latter half of the nineteenth century. By this time, the process of farm consolidation and the alternative of higher incomes in industry had raised the economic standard for marriage.

### “Ski-jump” fertility

Fertility within marriage was not a constant force even within the Malthusian framework prevailing in rural East Belgium. In Sart, fertility was more or less stable during the first half of the nineteenth century, but the Total Marital Fer-

---

<sup>3</sup> Tilleur population grew from 507 to 6,642 between 1807 and 1900, and most of this growth happened only after the establishment of two modern coal-mines in 1828 and 1835.

<sup>4</sup> Textile cities, like Verviers, faced the opposite problem, an excess of women migrants. See Alter 1988; Desama 1985: 149.

tility Rate above the age of 20 (TMFR20+) <sup>5</sup> increased from 7.8 children per married woman in the 1830s to 8.9 in the 1850s (Tab. 1). We cannot measure marital fertility before 1846 in the Pays de Herve, but we do see an increase in the 1860s and 1870s. These increases in marital fertility in the third quarter of the nineteenth century continued until the beginning of fertility decline. In accord with patterns elsewhere in Europe (Eggerickx 1995), fertility decline occurred first in the urban areas of Liège and Verviers in the 1860s and spread to their industrial outskirts during the 1870s, but change was slow until the end of the century (Oris 1995). Table 1 shows that marital fertility in Tilleur had begun to fall in the 1870s. Sart followed the cities in the 1880s with a modest decrease to a TMFR20+ of 8.5 and then a more substantial decline to 6.7 in the next decade. In the Pays de Herve fertility decline is only noticeable in the 1890s, twenty to thirty years after it began in the urban environment.

A brief period of rising fertility on the eve of fertility decline is not uncommon (Dyson and Murphy 1985). Van de Walle (1974, 179) described trends in nineteenth-century French birth rates as a “ski jump,” and others have observed an increase in the level of fertility before the onset of fertility decline (Knodel 1988, 283-286; Alter 1988, 175; Perrenoud 1988a, 69; Lesthaeghe 1992, 310). In the Swiss case, Perrenoud (1988a, 69-74) sees the deliberate action of married couples, but he also cites the spread of wet-nursing in urban areas. Several authors have suggested that increases in fertility during the nineteenth century may have resulted from a reduction in the duration of breastfeeding (Vallin 1991, 51; Perrenoud 1988a: 71, 74). Livi-Bacci (1986), on the other hand, linked rising marital fertility in Italy to the prevalence of pellagra and generally poor nutrition, which had reduced fertility in earlier generations. Knodel (1988, 286) mentions a number of behavioral changes that could have raised marital fertility: a lower age at weaning, less separation of spouses, and greater libido.

We can examine some of these explanations with fertility histories from Sart. First, we have looked for changes in breastfeeding. Figures 4, 5, and 6 are “survivor” curves showing the percentage of women who had not experienced a birth by time since marriage or previous birth.<sup>6</sup> A curve that descends more rapidly indicates that women were having births earlier and that birth intervals were shorter and the birth rate was higher. The graphs begin at nine months to exclude premarital pregnancies in the marriage to first birth interval, and they end at four years, even though some births occurred later. Each figure shows three curves for the time periods in each community. The effect of breastfeeding on childbearing in Sart can be inferred by comparing the survivor curve

<sup>5</sup> We use the Total Marital Fertility above age 20 (TMFR 20+), because the high fertility rates of the few women were married before age 20 artificially inflate the TMFR. However, even the TMFR 20+ is an overestimate in our rural areas where most women married after age 25.

<sup>6</sup> Figures 4, 5, and 6 were computed in Stata 8 (Stata Corporation, 2004) using the Kaplan-Meier procedure.

following a child that lived to age two (Fig. 5) to the curves after marriage (Fig. 4) or a child death (Fig. 6), when no breastfeeding took place. Before 1847, only 15 percent of women with a surviving child had given birth again in less than 24 months, compared to 55 percent of those whose previous children had died and 73 percent of the brides. The effect of breastfeeding added approximately a year to the median birth interval in this period.

When we compare the survivor curves for 1812-1846 (heavy unbroken line) to those for 1847-1874 (heavy broken line), we see a clear shrinking of the average birth interval and an increase in fertility. All three types of birth intervals were shorter after 1846. The change appears at longer durations among women whose previous child was alive. After four years 29 percent of these women were still waiting for another birth in the earliest time period, compared to 23 percent from 1847 to 1874. In contrast, women without a surviving infant were slower to give birth before 1847, but they caught up around two years and nine months. At the end of three years 79 percent of women who were not breastfeeding had given birth in both of periods, 1812-1846 and 1847-74. Thus, women who were not breastfeeding were just as likely to have a birth, but their birth intervals were somewhat longer before 1846. This implies that the mid-century rise in fertility in Sart cannot be explained exclusively by an increase in the duration of breastfeeding or a decrease in the proportion who breastfed.

Fig. 4: Percent of women that have not had a birth by time since marriage and period, Sart, Belgium

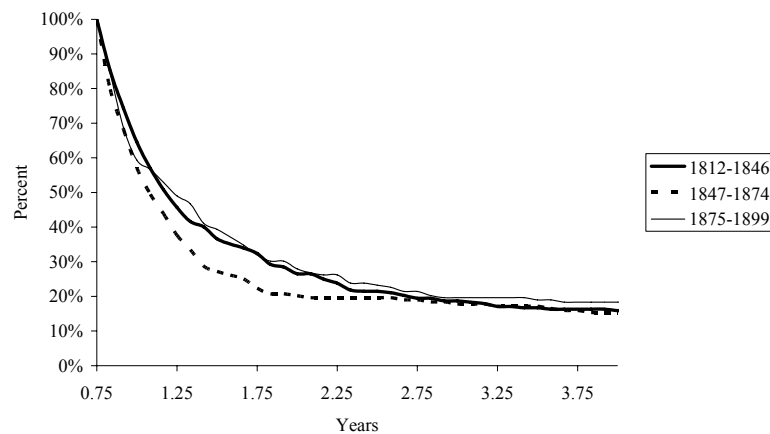




Fig. 5: Percent of women that have not had a birth by time since last birth and period when the previous child is alive, Sart, Belgium

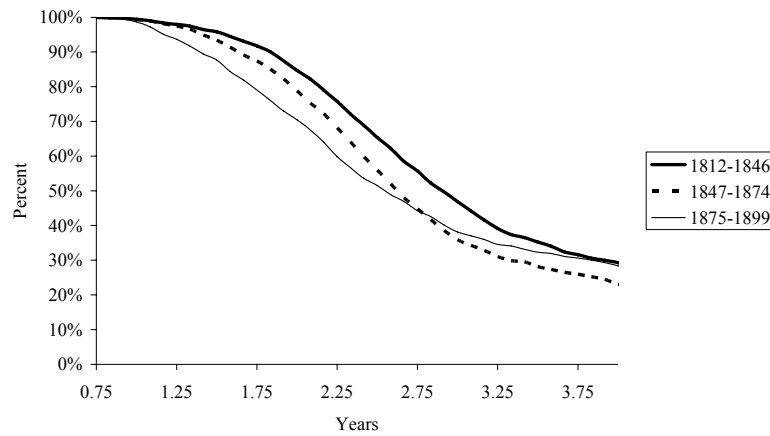
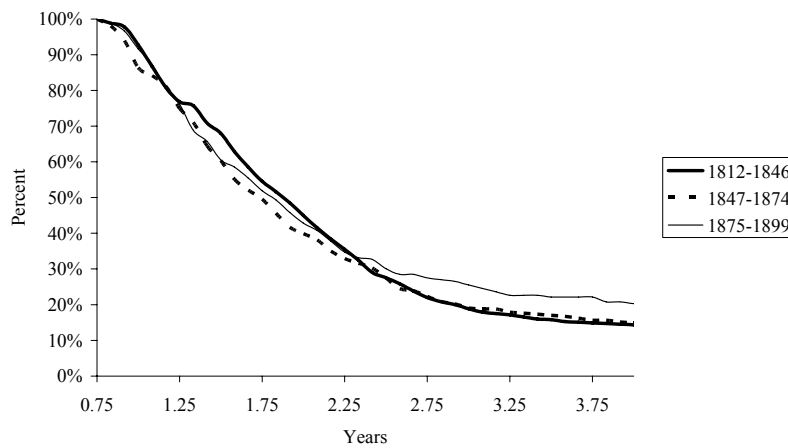


Fig. 6: Percent of women that have not had a birth by time since last birth and period when the previous child is dead, Sart, Belgium



A second possibility is that the changes observed in Figures 4, 5, and 6 were due to improvements in nutrition. We have strong evidence that nutrition was improving during this period from the heights of men examined for military service. While the average height of young men in Sart was around 161 centi-

meters before 1840, it had risen to over 165 centimeters in the 1860s (Alter, Neven, Oris 2004a). There are also signs that poverty had an impact on fertility in early nineteenth-century Sart. We find that women in households headed by day laborers, the poorest occupational group, had lower fertility in the period before 1847.<sup>7</sup> Between 1812 and 1846 the TMFR20+ for day laborers was 7.1 children per woman, compared to 7.9 for farmers. In the next period fertility increased for both groups, but it was higher for day laborers, whose TMFR20+ rose to 9.3 compared to 8.6 for farmers. Event history analysis of fertility (not shown) also shows that day laborers were more sensitive to prices than other groups in Sart. Unfortunately, the literature does not provide a clear guide to the links between maternal nutrition and fertility. In general, physiologists have concluded that the effects of undernutrition are large, while demographers tend to dismiss these effects as small and nearly unmeasurable (Wood 1994: 522-29).

Finally, a third alternative is that couples intentionally reduced their fertility before 1850. This could have taken the form of increasing the spacing between births to reduce the overall number (Perrenoud 1988a).<sup>8</sup> Or, couples could have postponed births in bad times, when the burden of an additional mouth to feed would have been most unwelcome, without intending to limit the size of the family (Bengtsson and Dribe 2006). There has been a long debate about whether any forms of birth control were used before the onset of fertility decline. Some advocates of Henry's (1961) "natural fertility" hypothesis argue that birth spacing to limit family size was not practiced (Knodel 1987; Knodel and van de Walle 1979), but there have been increasingly strong challenges to this position (Anderton and Bean 1985; Mineau, Bean and Anderton 1989; Szreter and Garrett 2000; Van Bavel 2004).

## Mortality, reproduction, and the paradox of growth

Fertility in our study sites exceeded losses due to high mortality, except for Tilleur in 1846-1849 which were years of economic crisis and epidemic. We can see the effect of mortality by looking at the Net Rate of Reproduction<sup>9</sup> (NRR) in Table 1, which takes mortality as well as fertility into account. The

<sup>7</sup> In the first half of the nineteenth century day laborers measured for military service were four centimeters shorter than farmers and seven centimeters shorter than men who were still students at age 20 (Alter, Neven, Oris 2004a).

<sup>8</sup> In 1876 Dr. Kuborn (1877, 613) of Seraing wrote: "The custom among the people is not to begin weaning until fourteen or fifteen months, sometimes even later, because women are convinced that breastfeeding as long as possible acts as an obstacle to over-abundant fertility."

<sup>9</sup> NRR is calculated as  $TFR * 0.488 * L30$  where 0.488 is the average sex ratio at birth and L30 is the proportion of women who are still alive at the age of 30, 30 being an approximation of the average age at birth.

NRR shows the relative size of successive generations by estimating the number of daughters who would survive to their mothers' average age at birth. Table 1 also shows that changes in mortality sometimes counteracted trends in fertility. For example, the strong upward trend in the NRR in Tilleur is due to falling mortality not to increasing fertility. The NRRs for the Pays de Herve suggest that demographic pressure rose moderately but continuously from the 1840s to the 1870s. In Sart the relatively high measures of reproduction in the 1840s and 1850s help to explain why these Ardennes peasants started to move to the cities then. We also see that falling mortality raised the NRR in Sart from 1.44 in the 1870s to 1.54 in the 1880s even though fertility was falling. This improvement was primarily due to lower mortality after age one, because infant mortality changed very little before 1900.

Improving survival rates signify the successful adaptation of these rural societies to the collapse of protoindustry. Their success illustrates the complexity of the escape from the Malthusian demographic regime, a move "from hunger to modern economic growth" (Bengtsson and Saito 2000) that took unexpected roads, even in the countryside. In a previous contribution on mortality in Eastern Belgium we described a "paradox of growth" (Alter, Neven, Oris, 2004b). While the Industrial Revolution lifted the threat of the Malthusian positive check, expanding communities around Liège and Verviers suffered a serious "epidemiological depression." During the second third of the nineteenth century uncontrolled urban growth often reduced life expectancy to just 30 years in places like Tilleur. In contrast, life expectancy was 12 to 18 years higher in rural areas where economic resources were actually declining.

As we have seen, this paradox does not mean that poverty was absent in the countryside, especially in the Ardennes which was considered one of the poorest areas in Belgium. On the contrary, in the early nineteenth century officials and travellers commented on the signs of poverty in the Ardennes (Vlieberghs et Ulens 1912; Hoyois 1981), and the short stature of men in Sart is a strong indication that children were poorly nourished. Men born in Sart between 1816 and 1830 were only 160 centimeters tall when they were measured for military service at age 19. This is more than two centimeters shorter than those from the Hervian village of Charneux, and almost five centimeters shorter than the average for Belgium (Alter, Neven and Oris, 2004a). Young men in England, Sweden, Denmark, and France were already taller than 165 centimetres (Fogel 1994: Tab. 1; Floud 1994). The economic vulnerability of inhabitants of Sart during the first half of the century is also reflected in higher mortality during years of high prices. The size of this effect varied by age, sex and marital status, but it was quite large in some groups. This pattern disappeared after 1850, except among married women who remained susceptible to high prices until 1875 in both Sart and the Pays de Herve (Alter, Neven and Oris, 2004b). The persistent association between prices and the mortality of married women

suggests that they were willing to sacrifice their own health to feed their husbands and children when times were bad.

## Conclusion

Industrialization gradually transformed the Malthusian demographic regime in Eastern Belgium into something else. When Napoleon was defeated, the reproductive system still rested on late marriage and permanent celibacy. Widespread proto-industrialization had not turned the inhabitants of Eastern Belgium into early-marrying proletarians, but the combination of population growth and rural de-industrialization put the system under stress. Until 1850, variations and differentials in fertility were linked to economic stress. The poorest segment of society had not only lower fertility but higher susceptibility to short-term movements in prices. When further restrictions on marriage did not relieve the pressure, young people turned to opportunities in growing industrial areas in and around Verviers and Liège. Marriage was easier there, at least by contemporary Belgian standards. Moreover, rural economic development depended upon changes in agriculture, which required reducing the size of the rural population through out-migration.

Although we cannot identify the process, we can see that marital fertility was rising in the middle of the nineteenth century. Whether low fertility in Sart before 1850 was due to poor nutrition or to deliberate choice, however, the underlying cause was the same: poverty. The economic situation improved after 1850, as accelerating industrialization drew even more people from the countryside into the city. Sensitivity to economic stress disappeared, and increasing male stature indicates improvements in nutritional status. In earlier centuries this may have loosened Malthusian restraints, but that did not happen. Standards for social and economic success were no longer being set in rural areas. Indeed, nuptiality in Sart and the Pays de Herve decreased even more to offset higher fertility and lower mortality. Restrictions on marriage continued after 1850, but the logic changed from survival to accumulation. Siblings who did not marry or left to work in the cities allowed those remaining on the land to consolidate their holdings.

To a large extent, inhabitants of East Belgian countryside were able to cope with rural deindustrialization, population pressure and urban industrial development. It is not reasonable to see their late transition to low marital fertility as a lack of adaptive capacities, when they showed exactly the contrary throughout the century. In fact, their late adoption of birth control was a consequence of their successes. It was provoked by the accelerating decrease in childhood mortality and by the transformation of the old agrarian regimes to larger farms and more advanced techniques consistent with the modern industry developing in nearby.

## References

- Alter, George. 1988. *Family and the Female Life Course: The Women of Verviers, Belgium, 1849-1880*. Madison: University of Wisconsin Press.
- Alter, George and Michel Oris. 1999. "Access to marriage in the East Ardennes during the 19th century", in I. Devos and L. Kennedy (eds.), *Marriage and rural economy. Western Europe since 1400*, Turnhout: Brepols, 133-151.
- Alter, George and Michel Oris. 2000. "Mortality and economic stress: individual and household responses in a nineteenth-century Belgian village", in T. Bengtsson and O. Saito (eds.), *Population and economy. From hunger to modern economic growth*, Oxford, 335-370.
- Alter, George, Neven Muriel and Oris Michel. 2004a. "Stature in Transition: A Micro-level Study from Nineteenth-century Belgium", *Social Science History* 28 (2): 231-247.
- Alter, George, Muriel Neven and Michel Oris. 2004b. "Mortality and modernization in Sart and surroundings, 1812-1900", in Tommy Bengtsson, Cameron Campbell and James Lee (eds.), *Life under pressure: mortality and living standards in Europe and Asia, 1700-1900*, Harvard Ms., Massachusetts Institute of Technology Press, 173-208.
- Anderton, D.L. and L.L. Bean. 1985. "Birth Spacing and Fertility Limitation – a Behavioral-Analysis of a 19th-Century Frontier Population." *Demography* 22(2):169-183.
- Bengtsson, T. and M. Dribe. 2006. "Deliberate control in a natural fertility population: Southern Sweden, 1766-1864." *Demography* 43(4):727-746.
- Bengtsson, Tommy and Osamu Saito (eds.). 2000. *Population and economy. From hunger to modern economic growth*, Oxford: Oxford University Press.
- Bideau A., Bardet J.-P., Houdaille J. 1988. "La fécondité", in *Histoire de la population française. t. 2. De la Renaissance à 1789*, Paris: Presse universitaires de France, 349-398.
- Braun, Rudolph. 1990. *Industrialisation and everyday life*, Cambridge-New York: Cambridge University Press.
- Capron, Catherine. 1998. "Essai de reconstruction automatique des parentés à partir du registre de population belge", in *Revue Informatique et Statistique dans les Sciences humaines*, 9-49.
- Coale Ansley J., Watkins Susan C. 1986. *The decline of fertility in Europe*, Princeton: Princeton University Press.
- Corsini, Carlo. 2000. "Introduction", in Muriel Neven and Catherine Capron (eds.), *Family Structures, Demography and Population. A Comparison of Societies in Asia and Europe*, Liège: Laboratoire de Démographie de l'Université de Liège, 9-21.
- Davis, Kingsley. 1963. "The theory of change and response in modern demographic history." *Population Index* 29:345-66.
- Desama, Claude. 1985. *Population et révolution industrielle. Évolution des structures démographiques à Verviers dans la première moitié du 19e siècle*, Paris, Les Belles Lettres.
- Dyson, T., and M. Murphy. 1985. "The Onset of Fertility Transition." *Population and Development Review* 11 (3):399-440.

- Eggerickx, Thierry. 1995. "Urbanisation et déclin de la fécondité légitime en Europe au 19<sup>e</sup> siècle." In *Transitions démographiques et sociétés. Chaire Quetelet 1992*, ed. D. Tabutin, T. Eggerickx and C. Gourbin. Louvain-la-Neuve Academia-L'Harmattan.
- Flinn, Michael W. 1981. *The European demographic system: 1500-1820*, Baltimore: The Johns Hopkins University Press.
- Floud, Roderick. 1994. "The heights of Europeans since 1750: A new source for European economic history," in John Komlos (ed.) *Stature, Living Standards, and Economic Development. Essays in Anthropometric History*. Chicago: University of Chicago Press, 9-24.
- Fogel, Robert W. 1994 "Economic-growth, population theory, and physiology – the bearing of long-term processes on the making of economic-policy." *American Economic Review* 84 (3): 369-95.
- Gutmann, Myron P. 1988. *Towards the Modern Economy. Early Industry in Europe, 1500-1800*, Philadelphia: Temple University Press.
- Gutmann, Myron P. 1991, "How do urban and rural industrial populations grow? Migration and natural increase in Verviers and its hinterland?", in *Historiens et populations. Liber Amicorum Etienne Hélin*, Louvain-la-Neuve: Academia, 411-440.
- Gutmann, Myron P., Leboutte, René. 1984. "Rethinking protoindustrialization and family", in *Journal of Interdisciplinary History*, 14 (3), 587-608.
- Henry, L. 1961. "Some data on natural fertility." *Eugenics Quarterly* 8:81-91.
- Hoyois, Giovanni. 1981. *L'Ardenne et l'Ardennais. L'évolution économique et sociale d'une région*, t. 1, Bruxelles.
- Knodel, J. 1987. "Starting, Stopping, and Spacing during the Early Stages of Fertility Transition – the Experience of German Village Populations in the 18<sup>th</sup> and 19<sup>th</sup> Centuries." *Demography* 24(2):143-162.
- Knodel, John. 1988. *Demographic Behavior in the Past: A Study of Fourteen German Village Populations in the Eighteenth and Nineteenth Centuries*. Cambridge: Cambridge University Press.
- Knodel, J. and E. van de Walle. 1979. "Lessons from the Past: Policy Implications of Historical Fertility Studies." *Population and Development Review* 5(2): 217-245.
- Kriedte, Peter, Hans Medick, and Jürgen Schlumbohm. 1981. *Industrialization before industrialization: rural industry in the genesis of capitalism*. Cambridge: Cambridge University Press.
- Kuborn, Hyacinthe. 1877. "Rapport sur la mortalité des nouveau-nés," in *Congrès international d'Hygiène, de Sauvetage et d'Economie sociale de Bruxelles* (1876), Bruxelles, vol. 1.
- Leboutte, René. 1988. *Reconversions de la main-d'oeuvre et transition démographique: les bassins industriels en aval de Liège, XVII<sup>e</sup>-XX<sup>e</sup> siècles*, Paris: Les Belles-Lettres.
- Leboutte, René. 1996. "Introduction", in Id. (éd.), *Proto-industrialisation. Recherches récentes et nouvelles perspectives. Mélanges en souvenir de Franklin Mendels*, Genève: Droz, 1-8.
- Lesthaeghe, Ron. 1992. "Motivation et légitimation: conditions de vie et régimes de fécondité en Belgique et en France du XVI<sup>e</sup> siècle au XVIII<sup>e</sup> siècle", in Blum A.,

- Bonneuil N., Blanchet D. (eds), *Modèles de la démographie historique*, Paris: INED, 275-317.
- Levine, David. 1977. *Family formation in an age of nascent capitalism*. New York: Academic Press.
- Livi-Bacci, Massimo. 1986. "Fertility, Nutrition, and Pellagra: Italy during the Vital Revolution." *Journal of Interdisciplinary History* 16 (3):431-54.
- Mendels, Franklin F. 1972. "Proto-Industrialization: The First Phase of the Industrialization Process," *Journal of Economic History* 32 (1), 241-261.
- Mendels, Franklin. 1984. "Niveau des salaires et âge au mariage en Flandre, XVIIe-XVIIIe siècles," in *Annales. Economies. Sociétés. Civilisations*, n° 5-6, 939-956.
- Mineau, G.P., L.L. Bean, and D.L. Anderton. 1989. "Migration and Fertility – Behavioral-Change on the American-Frontier." *Journal of Family History* 14(1):43-61.
- Neven, Muriel. 2003. *Individus et familles: les dynamiques d'une société rurale. Le Pays de Herve dans la seconde moitié du XIXe siècle*, Genève: Droz.
- Oris, Michel. 1990. "L'urbanisation de la province de Liège, 1800-1970. Sur un concept, son approche et son usage," *Bulletin trimestriel du Crédit Communal de Belgique*, n° 172, 77-99.
- Oris, Michel. 1995. "La transition de la fécondité légitime dans le milieu urbain wallon et bruxellois," in Dominique Tabutin et al. (eds), *Transitions démographiques et sociétés. Chaire Quetelet 1992*, Louvain-la-Neuve: Academia, 359-379.
- Oris, Michel. 1996. "Fertility and migration in the heart of the industrial revolution," *The History of the Family. An International Quarterly*, 1 (2), 169-182.
- Oris, Michel. 2000. "The age at marriage of migrants during the industrial revolution in the region of Liège," *The History of the Family. An International Quarterly*, 5 (4), 391-413.
- Perrenoud, Alfred. 1988a. "Espace et arrêt dans le contrôle des naissances," *Annales de Démographie Historique*, 59-78.
- Perrenoud, Alfred. 1988b. "Les transitions démographiques." *Annales de Démographie historique*:7-11.
- Schofield, Roger S. 1985. "English marriage patterns revisited," *Journal of Family History*, 9, 2-20.
- Servais, Paul. 1981. *La rente constituée dans le Ban de Herve au XVIIIe siècle*, Bruxelles: Crédit communal de Belgique.
- Servais, Paul. 1982. "Les structures agraires du Limbourg et des pays d'Outre-Meuse du XVIIe au XIXe siècle," *Annales. Economies. Sociétés. Civilisations*, 37 (2), 303-319.
- Szreter, S. and E. Garrett. 2000. "Reproduction, Compositional Demography, and Economic Growth: Family Planning in England Long Before the Fertility Decline." *Population and Development Review* 26(1):45-80.
- Vallin, Jacques. 1991. "Mortality in Europe from 1720 to 1914. Long-term trends and changes in patterns by age and sex." In *The decline of mortality in Europe*, ed. R. Schofield, D. S. Reher and A. Bideau. Oxford: Clarendon Press.
- Van Bavel, Jan. 2001a. *Demografische reproductie en sociale evolutie: Geboortebeperking in Leuven, 1846-1910*, Leuven: Universitair Press.

- Van Bavel, Jan. 2001b. "Family control, bridal pregnancy, and illegitimacy. An event history analysis in Leuven, Belgium, 1846-1856," *Social Science History*, 25 (3), 449-479.
- Van Bavel, J. 2004. "Deliberate birth spacing before the fertility transition in Europe: Evidence from nineteenth-century Belgium." *Population Studies-a Journal of Demography* 58(1):95-107.
- Vandenbroeke, Christian. 1984. "Le cas flamand : évolution sociale et comportements démographiques aux XVIIe-XIXe siècles," in *Annales. Economies. Sociétés. Civilisations*, n° 5-6, 915-938.
- Van Der Hertten, Bart, Michel Oris, and Jan Rogiers (eds).1995. *La Belgique industrielle en 1850 : deux cents images d' un monde nouveau*, Bruxelles: Crédit Communal de Belgique.
- Van de Walle, Etienne. 1974. *The female population of France in the nineteenth century: a reconstruction of 82 départements*. Princeton, N.J.: Princeton University Press.
- Vliebergh, Emile and Robert Ulens. 1912. *L'Ardenne. La Population agricole au XIXe siècle*. Bruxelles: Librairie Albert Dewit.
- Weir, David R. 1984. "Rather Never than Late: Celibacy and Age at Marriage in English Cohort Fertility, 1541-1871", *Journal of Family History*, 340-354.
- Wood, James W. 1994. "Maternal nutrition and reproduction: why demographers and physiologists disagree about a fundamental relationship. AF-Department of Anthropology, Pennsylvania State University, University Park 16802." *Annals of the New York Academy of Sciences* 709:101-16.
- Wrigley E.A., Schofield R.S. 1981. *The population history of England, 1541-1871. A reconstruction*, London.